(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 777 447 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
14.02.2001 Bulletin 2001/07

(21) Application number: **95926707.1**

(22) Date of filing: **14.07.1995**

(51) Int Cl.[7]: **A61B 17/72**

(86) International application number:
PCT/US95/08917

(87) International publication number:
WO 96/02203 (01.02.1996 Gazette 1996/06)

(54) **MODULAR INTRAMEDULLARY NAIL**

MODULARER INTRAMEDULLARNAGEL

CLOU INTRAMEDULLAIRE MODULAIRE

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB IE IT LI NL PT SE

(30) Priority: **15.07.1994 US 275806**

(43) Date of publication of application:
11.06.1997 Bulletin 1997/24

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EP 0 777 447 B1

Printed by Jouve, 75001 PARIS (FR)

Description

1. Field of the Invention:

[0001] The present invention relates to an intramedullary nail system for the repair of long bone fractures, which has a modular design for enabling a surgeon to assemble a nail or related implant during surgery which most closely fits the patient's needs.

2. Background of the Invention:

[0002] Intramedullary nails have become the preferred implant treatment in many long bone fracture cases. As the use of intramedullary nails has become more popular, the design of the implants has advanced so that there are particular designs for different types of fractures. Nails having a particular configuration are desirable for certain indications. Because of wide variation of the long bones in patients, the particular style of nail is preferably available in a range of lengths, diameters, and shapes. As a result, the surgeon must have at hand a large inventory of styles and sizes to accommodate the variety of indications. Examples of such styles include, but are not limited to femoral reconstruction, intramedullary hip screw, and femur components of total hips.

[0003] One solution to this variation problem is to provide a modular nail system where a surgeon can select various component parts and assemble them to fit a particular patient's needs. Such a system is taught in U.S. patent 4,805,607 to Engelhardt et al. where a modular intramedullary nail system has elongated base nails and extension members of different lengths and diameters. The base nail is the primary structural component of the system and the extension member is designed to fit on the proximal end of a base nail. By selecting various combinations of base nails and extension members, nails of a desired length and diameter can be constructed. The component parts are locked together by a pair of snap lock springs formed on the proximal end of the base nail, which include engagement tongs with locking barbs at the trailing end which are radially depressed in order to engage a counterbore on the extension member. A screw is inserted through a hole in the modular components after the rod has been implanted for preventing the tongs from disengaging.

[0004] The inventors have determined it is advantageous to have a nail system with greater modularity than in a system such as shown in the Engelhardt patent, and one providing an easier and more secure method of attaching the components, which is assembled without utilizing a screw to hold the components together.

[0005] US A 5 122 141 is the closest prior art document and corresponds to the preamble of the independent claim. This document discloses a modular intramedullary nail whose modular sections are connected by conical members. No separate means are provided for resisting relative rotational movement. Such a modular system is thus less secure than the Engelhardt system.

SUMMARY OF THE INVENTION

[0006] The present invention is directed to improved intramedullary nails providing a modular intramedullary nail system having at least two, and preferably three modular components. Modular components include proximal and distal sections and, if applicable, a central nail section, with each section constructed in a variety of sizes, diameters, and styles for fitting a wide range of anatomies and indications. The modular components of the present invention are quickly and easily assembled having joints of high mechanical and torsional integrity.

[0007] The modular components of the present invention include a locking mechanism for connecting and locking together adjacent modular components which can quickly provide a positive locking fit that resists relative twisting or rotational movement between the components as well as translation. The locking mechanism also includes an facile alignment of components during the assembly process.

[0008] More specifically, assembly of the modular components of the present invention is achieved by one modular component having a bore with a tapered surface adapted to securely engage a cooperating tapered pin surface, with such engagement resulting in a secure connection which is resistant to rotational and translational forces. An example of a modified taper and bore providing such secure connection is a configuration known as a Morse taper. Resistance to relative rotational movement can be achieved by providing a polygonal projection at the end of the taper. In the illustrated embodiment, the cooperating pin and bore are hexagonally shaped to achieve a snug fit.

[0009] In a preferred embodiment, the components are provided with an alignment mechanism to ensure the components are properly assembled. This is achieved, for example, by providing easily observed alignment indicia on the outer surfaces of the component parts, e.g., markings, indentations, tabs, flanges or keys on one component with corresponding indicia on the mating component. Asymmetric tabs, flanges or keys, and corresponding slots, may also be used to ensure the components are aligned in the proper configuration.

[0010] In an alternative embodiment, the taper or bore of one component may be adapted to accept more than one type of mated component, with each match corresponding to direct assembly of a specific implant design.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] In order to acquire a better understanding of the invention, reference may be had to a detailed description of exemplary embodiments set forth below, to be considered along with the appended drawings, in

which:

Figure 1 is a plan view of a modular intramedullary designed in accordance with the present invention, in which the modular components are assembled;
Figure 2 is a plan view of view of the modular system shown in Fig. 1, with the distal and proximal sections separated from the central section;
Figure 3 is a plan view, partially in section, of the central section of the modular system showing in particular the female sockets at both ends;
Figure 4 is an end view of the central section shown as line 4-4 in Fig. 3;
Figure 5 is a second end view of the central section shown in Fig. 3;
Figure 6 is a section view looking through a section line 6-6 of Fig. 3;
Figure 7 is an plan view, partially in section, of the proximal end of the modular system shown in Figs. 1 and 2;
Figure 8 is a sectional view of the proximal end shown in Fig. 7, rotated 90° from the view shown in Fig. 7;
Figure 9 is an end view of the proximal end shown as line 9-9 in Figs. 7 and 8;
Figure 10 is a second end view of the proximal end shown as line 10-10 in Figs. 7 and 8;
Figure 11 is a plan view of the distal section of the modular system shown in Figs. 1 and 2;
Figure 12 is an end view of the distal section shown as line 12-12 in Fig. 11;
Figure 13 is a plan view, partially in section, of an alternative locking mechanism for the intramedullary nail system shown in Figs. 1 and 2;
Figures 14 is an end view of the male portion of the alternative locking system shown as line 14-14 of Fig. 13;
Figures 15 is an end view of the female portion of the alternative locking system shown as line 15-15 of Fig. 13;
Figure 16 is another alternative locking mechanism of the intramedullary nail system of the present invention;
Figures 17 is a end view of the alternative locking mechanism shown as line 17-17 of Fig. 16;
Figures 18 is a end view of the alternative locking mechanism shown as line 18-18 of Fig. 16;
Figure 19 is a plan view partially in section, of another alternative locking mechanism in accordance with the present invention;
Figures 20-22 are end views of three male components for the alternative embodiment shown in Fig. 19;
Figure 23 is an end view of the female component for the alternate embodiment shown in Fig. 19; and
Figure 24 is a plan view of another alternative locking mechanism.
Figure 25 is a plan view of an alternative embodiment having a portion of a hip prosthesis attached to the proximal end of the central section.
Figure 26 is a plan view of an alternative embodiment having an intramedullary hip screw attached to the proximal end of the central section.

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0012] Referring to Figs. 1 and 2, one exemplary embodiment of the modular intramedullary nail system of the present invention is shown. The term "modularity" for the system of the present invention is used to describe the various sections which are used to make up an assembled nail 10 as shown in Fig. 1. The nail 10 is formed of two or more, and preferably three discreet sections, a central section 12, a proximal section 14 to form a proximal end P and a distal section 16 to form a distal end D. Alternatively, the nail might be formed of proximal and distal sections without having a central section. When assembled as shown in Fig. 1, the sections form a complete intramedullary nail which in accordance with known surgical procedures can be inserted into a long bone of a patient in order to stabilize a fracture.

[0013] Fig. 2 shows the system of Fig. 1 with the three components in a disassembled state. As may be appreciated, each of the components is only one of a number of different sizes and styles available to the physician so that the system shown in Figs. 1 and 2 represent the desired or appropriate system as finally determined by the surgeon.

[0014] As shown in Fig. 2, the component sections are separate elements which are manufactured independently and need to be assembled in order to form the operative nail. The modularity of this product is advantageous since it permits a surgeon to select the appropriate components for a particular patient from a variety of sizes, shapes and styles, and assemble those components in order to provide a nail having the proper characteristics for the specific indications.

[0015] In general, it is preferred that the proximal and distal ends of the central section have different taper diameters, and correspondingly the proximal and distal components connectable to the cental section have different taper diameters. More preferably, the proximal taper is larger than the distal taper of the cental nail section. The difference in taper diameters prevents improper assembly of modular components, e.g., application to the wrong end of the central section, and also prevents stress risers at points in the proximal end of the central section.

[0016] The nail 10 of the present invention has a locking mechanism between adjacent components which is designed so that the pieces may easily be fitted together and locked to each other such that they will resist separation and rotational movement relative to each other when they are subjected to stresses after implantation.

[0017] As shown in greater detail in Figs. 3-6, the central section 12 has an elongated portion 18 with flutes 20 on its outer surface and a hollow opening 22 which is generally similar in shape to the outer surface (see Fig. 6).

[0018] A socket or female connection 24 is formed in both ends of the central section 12 as shown in Figs. 3-5. The only difference between the two ends illustrated is that the distal end D has a smaller diameter than the proximal end P. The configuration of both sockets or female portions 24 of the locking mechanisms are similar. They include a tapered inner wall 26 which is conical in shape and decreases in diameter from the outer open portion of the socket inwardly. The tapered wall 26 is adapted to mate with a tapered male connection section 28 formed on proximal section 14 or distal section 16 (see Figs. 7, 10, 11, and 12). Preferably, the distal section mates only with the distal end of the central section, and likewise, the proximal section mates only with the proximal end of the central section to ensure proper orientation of the implant. The tapered surfaces 26, 28 are complementary and taper at an equal angle so that the two surfaces form a self-locking fit such as is commonly known as a Morse taper. This type of fitting is characterized by forming a tight friction-fit upon impact.

[0019] The proximal and distal sections 14, 16 may be locked into sockets 24 by simply inserting them as shown generally in Fig. 1 and then impacting the outer end of the sections in order to lock the Morse taper. In the preferred embodiment, an impact driver may be used by the surgeon to provide the impact. Such an impact driver is a commercially available product which carries a tooled end portion having, for example, a commercial screw driver or wedge tip (not shown). One driver which has been found appropriate for medical products is supplied by the Starrett Company, which impacts as much as 300 pounds of load when it is used.

[0020] Although the modular components are illustrated as having female tapers on the central section and cooperating male tapers on the proximal and distal sections, it is understood that any combination of cooperating male and female tapers may be used to achieve the desired connections.

[0021] For some indications, e.g., those requiring a large diameter nail, the inside diameter of the nail cannula may be larger than the diameter of the taper. For example, a "bottle bore" configuration may be used, where the ends of nail segment are compressively swagged to a smaller diameter, that is, the outer surface of the nail segment is simultaneously and uniformly pinched so as to form a tapered diameter required for fitting together the modular components.

[0022] In order to hold the adjacent components together and to prevent them from twisting relative to each other after implantation in a human bone, the socket or female receptacle is formed with a polygonal, e.g., hexagonal opening 30 on the inner end of the tapered surface 26, which is sized and shaped to mate with a hexagonal male projection 32 formed on the outer end of the male taper 28 (see Fig. 7). The cooperating polygonal, e.g., hexagonal female and male sections 30, 32 are closely machined so that little if any relative twisting movement takes place between the adjacent modular components after the nail 10 is implanted. Obviously, other shapes may be used for these mating components in order to prevent this twisting action from taking place. The cooperating angular mating components may be used to align adjacent components in one or more preferred orientations, simply by rotating the components relative to each other.

[0023] In a preferred embodiment, the mating angular projection and socket are asymmetrical. As illustrated in Figs. 25 and 26, the hexagonal projection 32 and its corresponding socket 30 may be rounded at one facet 130, 132. Such asymmetry permits the cooperating ends to fit together only in a desired orientation and prevents incorrect alignment of component parts.

[0024] As shown in Fig. 7, the proximal end is provided with a pair of openings 34 in order to accommodate screws for holding the nail 10 relative to the bone in which it is implanted. As shown in Fig. 8, the proximal section 14 includes a hollow center opening 36 and a threaded female receptacle 38 for receiving a tool (not shown) for removing the nail if necessary. A notch 42 is formed at the outer end of the distal section 14 which cooperates with a tool (not shown) for inserting the nail in the bone of the patient.

[0025] A preferred embodiment of the distal section 16 is shown in Figs. 11 and 12 where, in addition to the tapered surface 28 and hexagonal projection 32, the outer surface includes elongated flutes 44 and an opening 46 which extends along the axis of the proximal section 16. A pair of openings 48, 50 are provided to accommodate anchoring screws.

[0026] As shown in Figs. 1 and 2, a pair of alignment arrows 53 are formed on the outer surface of the adjacent components in order to indicate to the surgeon the proper alignment of the sections relative to each other. These arrows may be scratched, etched or otherwise marked on the outer surface of the various sections. Any type of indicia which provide for a visual or mechanical indication of the proper orientation between the adjacent sections may be used.

[0027] Another way to insure proper alignment is by using a design such as that shown in the embodiment of Fig. 13 where adjacent nail sections 52, 54 have cooperating male and female sections in the form of a tapered outer surface 56 and a tapered inner surface 58 for providing a Morse taper fit as described above. However, as shown best in Figs. 14 and 15, the male tapered surface 56 has a projection 60 formed on its outer surface which is sized and shaped to fit into a slot 62 which extends from the surface of the tapered receptacle 58. The cooperation between the projection 60 and slot 62 provides resistance against any relative twisting between the adjacent components 52, 54 as well as to in-

sure that the components are properly aligned when they are assembled.

[0028] Another embodiment of the locking mechanism is shown in Figs. 16-18 where adjacent components 64, 66 have cooperating male and female tapers 68, 70 which lock together as discussed above. Instead of a projection 60 as shown in Fig. 13, a pair of flanges 72 are formed adjacent to the male taper 68, which fit into a pair of slots 74 formed adjacent to the female taper 70.

[0029] Another alternative locking mechanism is shown in Figs. 19-23 where adjacent sections 76, 78 are provided with cooperating male and female tapers 80, 82. The female taper 82 has a series of slots 84-88, shown in Fig. 23, which cooperate with various shapes of projections formed on the male taper 80 shown in Figs. 20-22. For example, the projections 90 shown in Fig. 20 mate with the slots 88 shown in Fig. 23, the projections 92 in Fig. 21 with the slots 84 in Fig. 23 and the projections 94 in Fig. 22 with the slots 86 in Fig. 23. Each of the sets of projections 90, 92 and 94 are different shapes and configurations so that only the projections designed to fit in a cooperating set of slots will allow insertion in those slots. This insures proper alignment between each individual component section 76 in the proper orientation without any mismatching. The use of the slots and projections also prevent relative twisting movement between the components after they are implanted in the human body.

[0030] Another embodiment for insuring rotational stability between adjacent components as shown in Fig. 24 where the adjacent components 96, 98 have cooperating male and female tapered surfaces 100, 102 which are offset at an angle a relative to the longitudinal axis of the components 96, 98, so that proper alignment and resistance against relative twisting movement are provided. This angled taper embodiment may also be employed to connect modular components resulting in the axis of either or both of the proximal or distal sections 14, 16 being oriented at an angle relative to the axis of the central section 12.

[0031] As shown in the exemplary embodiments of the invention described above, a modular nail system is provided with a positive and sure locking mechanism between adjacent components where they remain aligned after implantation because of the various ways of preventing translational or rotational motion between them. The Morse taper lock provided between the components is easy to connect and disconnect by using an impact tool as described above or other type of device. Alignment is achieved by various indicia on the outer surface of the adjacent sections or by various mating configurations in order to make sure that prior to implantation the sections are properly oriented relative to each other.

[0032] In an alternative embodiment illustrated in Figures 25 and 26, the modular proximal section of the system described may be an endo-recon type hip implant 110 or an intramedullary hip screw 112.

[0033] The foregoing description should be considered exemplary of the invention and not restrictive. It should also be understood that improvements and modifications can be made to the invention without departing from the scope of the invention as defined in the appended claims.

Claims

1. A modular intramedullary nail (10); comprising:

(a) a first nail component;
(b) a second nail component;
(c) connecting means for securing the first and second components together, the connection means including one component having a conical male connector section (28) and the other component having a conical female connector section (26), the connector section being tapered at about the same angle so they can be fitted together and secured upon impact; and
(d) movement resistance means associated with the connection means for resisting relative rotational and translational movement between the components,

wherein the first and second nail components are elongated members and characterised in that the means for resisting relative rotational movement comprise a slot (62, 74) and projection (60, 72) arrangement on the male and female connector sections or a shaped projection (32) on the male connector section and a shaped socket (30) on the female connector section, the projection and socket being shaped to prevent relative movement or conical sections being at an angle relative to the longitudinal axis of the nail components.

2. The modular nail (10) of Claim 1, further including at least one additional nail component connected to either the first or second nail component at an end opposite the other component.

3. The modular nail (10) of Claims 1 or 2, further including alignment means (53) associated with the connector means for assuring proper alignment between the components.

4. The modular nail (10) of Claim 3, wherein the first and second nail components are hollow members.

5. The modular nail (10) of claim 2, ,wherein the connection means has male and female connector sections that are frusto-conical in shape.

6. The modular nail (10) of claim 3, wherein the align-

ment means includes indicia formed in the adjacent outer surface apertures of the first and second nail components.

7. The modular nail (10) of claim 2, wherein at least one shaped projection and slot are formed on the tapered connector sections.

8. The modular nail (10) of claim 2, wherein at least one shaped projection and slot are formed adjacent to the tapered connector section.

9. The modular nail (10) of claim 8, wherein at least two different shaped slots are formed adjacent to one of the tapered connector sections, each of which co-operates with a different shaped projection formed on a cooperating tapered section.

10. The modular nail (10) of claim 2, wherein the alignment means and movement resistance means include forming the tapered surfaces about an axis oriented at an angle relative to the axes of the first and second nail components.

11. The modular nail (10) of claim 2, wherein the shaped projection and socket are hexagonal.

12. The modular nail (10) of claim 2, wherein one of said first or second nail components is a portion of a hip prosthesis.

13. The modular nail (10) of claim 12, wherein said portion of a hip prosthesis is an endo-recon hip implant.

14. The modular nail (10) of claim 12, wherein said portion of a hip prosthesis is an intramedullary hip screw.

Patentansprüche

1. Ein modularer Marknagel (10); bestehend aus:

(a) einer ersten Nagelkomponente;

(b) einer zweiten Nagelkomponente;

(c) einem Verbindungsmittel zur Befestigung der ersten und zweiten Komponente aneinander, wobei das Verbindungsmittel eine Komponente mit einem kegelförmigen Außenverbindungsabschnitt (28) umfaßt und die andere Komponente einen kegelförmigen Innenverbindungsabschnitt (26) umfaßt, wobei der Verbindungsabschnitt sich in ungefähr demselben Winkel verjüngt, damit sie ineinander gepaßt werden können und beim Aufeinandertreffen befestigt sind; und

(d) einem Bewegungswiderstandsmittel, das dem Verbindungsmittel zugeordnet ist, um der relativen Dreh- und Translationsbewegung zwischen den Komponenten zu widerstehen,

wobei die erste und zweite Nagelkomponente längliche Elemente sind und dadurch gekennzeichnet, daß das Mittel, das der relativen Drehbewegung widerstehen, aus einer Schlitz- (62, 74) und Vorsprung(60, 72) Anordnung auf dem Außen- und Innenverbindungsabschnitt oder einem geformten Vorsprung (32) auf dem Außenverbindungsabschnitt und einer geformten Fassung (30) auf dem Innenverbindungsabschnitt besteht, wobei der Vorsprung und die Fassung so geformt sind, daß sie der Relativbewegung widersteht oder die kegelförmigen Abschnitte in einem Winkel bezüglich der Längsachse der Nagelkomponenten liegen.

2. Modularer Nagel (10) gemäß Anspruch 1, weiters bestehend aus zumindest einer zusätzlichen Nagelkomponente, die mit der ersten oder der zweiten Nagelkomponente an einem der anderen Komponente entgegengesetzten Ende verbunden ist.

3. Modularer Nagel (10) gemäß Anspruch 1 oder 2, weiters bestehend aus einem Ausrichtungsmittel (53), das dem Verbindungsmittel zugeordnet ist, um die ordnungsgemäße Ausrichtung zwischen den Komponenten sicherzustellen.

4. Modularer Nagel (10) gemäß Anspruch 3, wobei die erste und zweite Nagelkomponente hohle Elemente sind.

5. Modularer Nagel (10) gemäß Anspruch 2, wobei das Verbindungsmittel Außen- und Innenverbindungsabschnitte aufweist, welche stumpfkegelförmig sind.

6. Modularer Nagel (10) gemäß Anspruch 3, wobei das Ausrichtungsmittel Anzeiger umfaßt, die in den angrenzenden Öffnungen der Außenfläche der ersten und zweiten Nagelkomponente gebildet sind.

7. Modularer Nagel (10) gemäß Anspruch 2, wobei zumindest ein geformter Vorsprung und ein Schlitz auf den verjüngten Verbindungsabschnitten gebildet sind.

8. Modularer Nagel (10) gemäß Anspruch 2, wobei zumindest ein geformter Vorsprung und ein Schlitz angrenzend an den verjüngten Verbindungsabschnitt gebildet sind.

9. Modularer Nagel (10) gemäß Anspruch 8, wobei zumindest zwei unterschiedlich geformte Schlitze angrenzend an einen der verjüngten Verbindungsab-

schnitte gebildet sind, die jeweils mit einem auf einem in gleicher Richtung wirkenden, verjüngten Abschnitt gebildeten, unterschiedlich geformten Vorsprung zusammenwirkt.

10. Modularer Nagel (10) gemäß Anspruch 2, wobei das Ausrichtungsmittel und das Bewegungswiderstandsmittel das Bilden der verjüngten Oberflächen um eine Achse, die in einem Winkel bezüglich der Achsen der ersten und zweiten Nagelkomponente ausgerichtet ist, umfaßt.

11. Modularer Nagel (10) gemäß Anspruch 2, wobei der geformte Vorsprung und die Fassung hexagonal sind.

12. Modularer Nagel (10) gemäß Anspruch 2, wobei die erste oder zweite Nagelkomponente ein Teil einer Hüftgelenkprothese ist.

13. Modularer Nagel (10) gemäß Anspruch 12, wobei der Teil einer Hüftgelenkprothese ein Endorekonstruktionshüftimplantat ist.

14. Modularer Nagel (10) gemäß Anspruch 12, wobei der Teil einer Hüftgelenkprothese ein Hüftgelenkmarknagel ist.

Revendications

1. Un clou intramédullaire modulaire (10) ; comprenant :

(a) un premier composant de clou ;

(b) un second composant de clou ;

(c) un moyen de raccordement destiné à solidariser les premier et second composants ensemble, le moyen de raccordement comportant un composant possédant une section connective mâle conique (28) et l'autre composant possédant une section connective femelle conique (26), les sections connectives étant effilées au même angle environ de façon à ce qu'elles puissent être emboîtées l'une dans l'autre et solidarisées à l'impact ; et

(d) un moyen de résistance au déplacement associé au moyen de raccordement destinés à résister au déplacement relatif de rotation et de translation entre les composants,

dans lequel les premier et second composants de clou sont des éléments allongés et caractérisé en ce que les moyens destinés à résister au déplacement relatif de rotation comprennent un agencement de fentes (62, 74) et de projections (60, 72) sur les sections connectives mâle et femelle ou une projection profilée (32) sur la section connective mâle et une douille profilée (30) sur la section connective femelle, la projection et la douille étant profilées pour empêcher le déplacement relatif ou les sections coniques étant en biais par rapport à l'axe longitudinal des composants de clou.

2. Le clou modulaire (10) de la revendication 1, comportant de plus au moins un composant de clou supplémentaire raccordé soit au premier soit au second composant de clou à une extrémité opposée à l'autre composant.

3. Le clou modulaire (10) des revendications 1 ou 2, comportant de plus un moyen d'alignement (53) associé aux moyens connectifs destinés à garantir un alignement correct entre les composants.

4. Le clou modulaire (10) de la revendication 3, dans lequel les premier et second composants de clou sont des éléments creux.

5. Le clou modulaire (10) de la revendication 2, dans lequel le moyen de raccordement possède des sections connectives mâle et femelle qui sont profilées de façon tronconique.

6. Le clou modulaire (10) de la revendication 3, dans lequel le moyen d'alignement comporte des marques formées dans les ouvertures de surfaces extérieures adjacentes des premier et second composants de clou.

7. Le clou modulaire (10) de la revendication 2, dans lequel au moins une projection et une fente profilées sont formées sur les sections connectives effilées.

8. Le clou modulaire (10) de la revendication 2, dans lequel au moins une projection et une fente profilées sont formées adjacentes à la section connective effilée.

9. Le clou modulaire (10) de la revendication 8, dans lequel au moins deux fentes profilées différentes sont formées adjacentes à l'une des sections connectives effilées, chacune d'entre elles coopérant avec une projection profilée différente formée sur une section effilée coopérante.

10. Le clou modulaire (10) de la revendication 2, dans lequel le moyen d'alignement et le moyen de résistance au déplacement composent les surfaces effilées formées autour d'un axe orienté en biais par rapport aux axes des premier et second composants de clou.

11. Le clou modulaire (10) de la revendication 2, dans lequel la projection et la douille profilées sont hexagonales.

12. Le clou modulaire (10) de la revendication 2, dans lequel un desdits premier ou second composants de clou est une portion d'une prothèse de hanche.

13. Le clou modulaire (10) de la revendication 12, dans lequel ladite portion d'une prothèse de hanche est un implant de hanche pour endo-reconstruction.

14. Le clou modulaire (10) de la revendication 12, dans lequel ladite portion d'une prothèse de hanche est une vis de hanche intramédullaire.

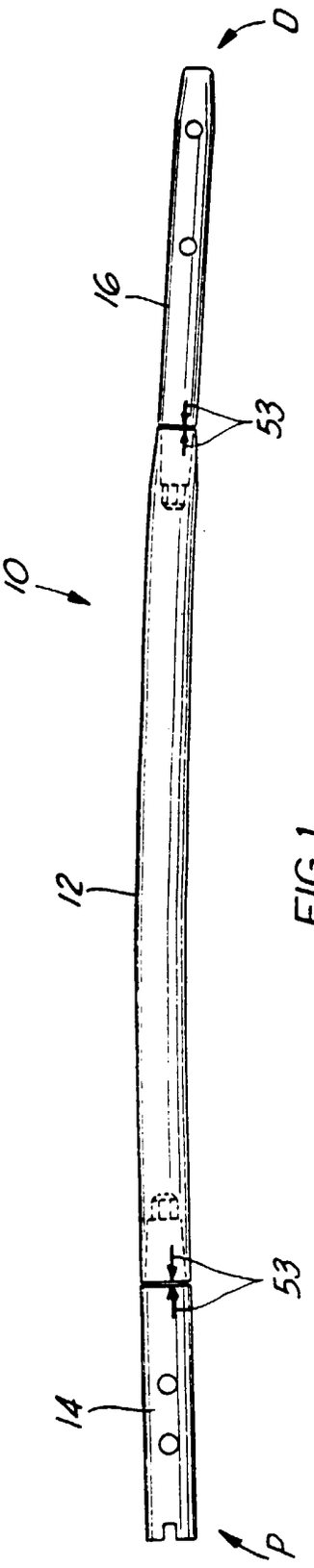


FIG. 1

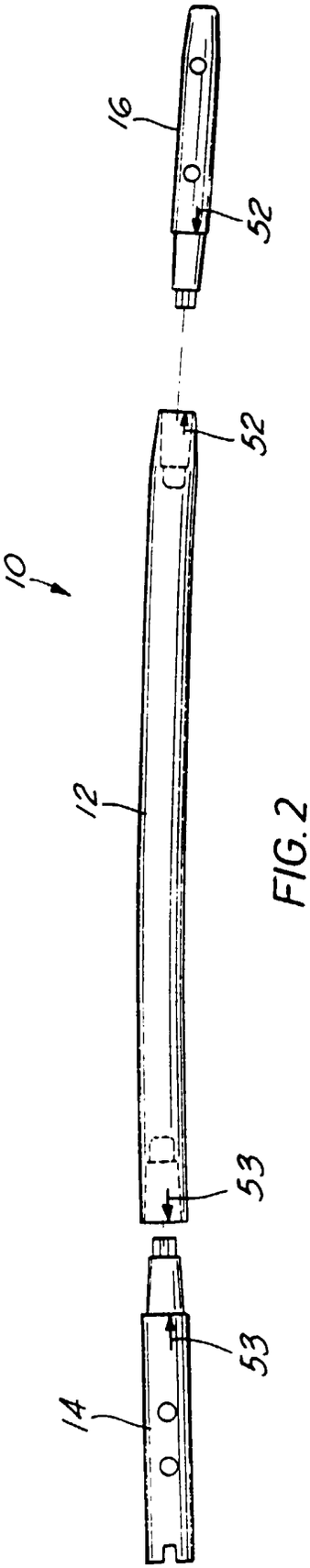


FIG. 2

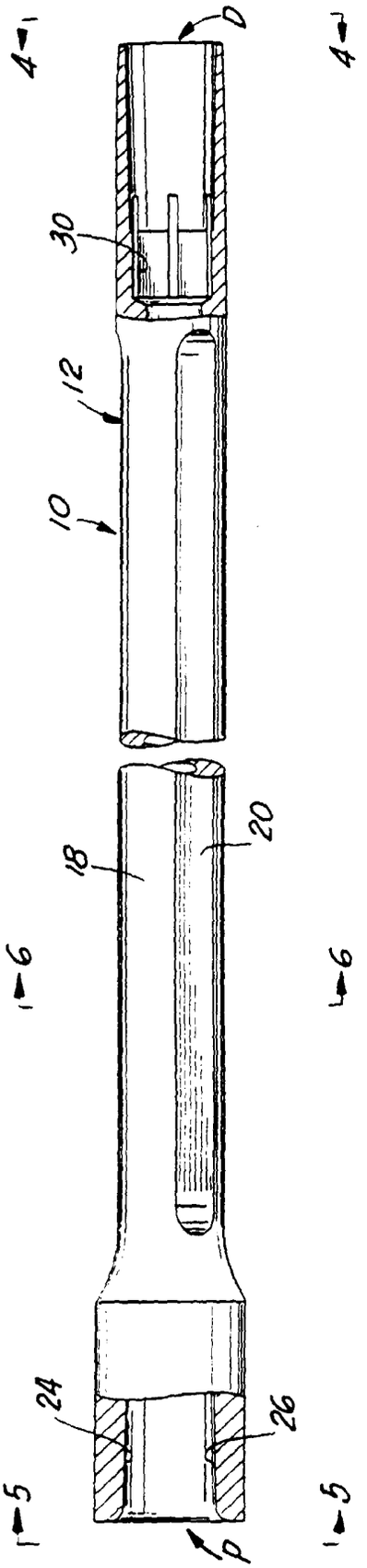


FIG. 3

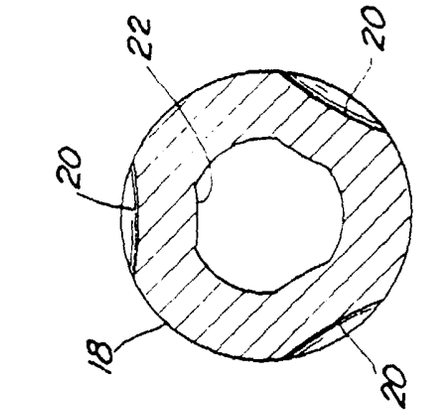


FIG. 6

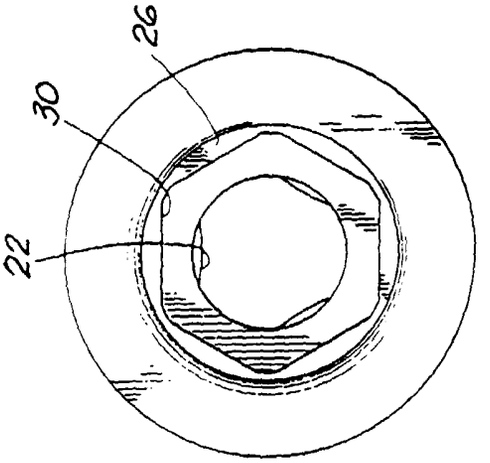


FIG. 5

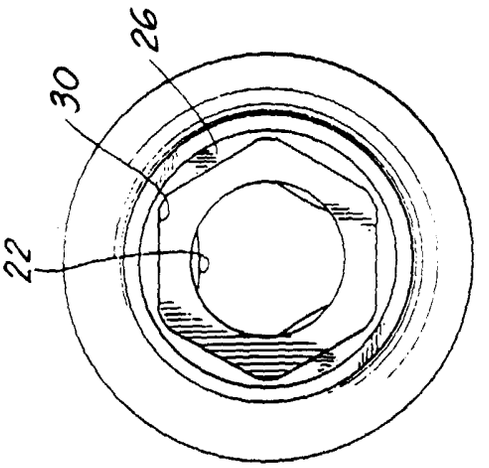


FIG. 4

FIG. 7

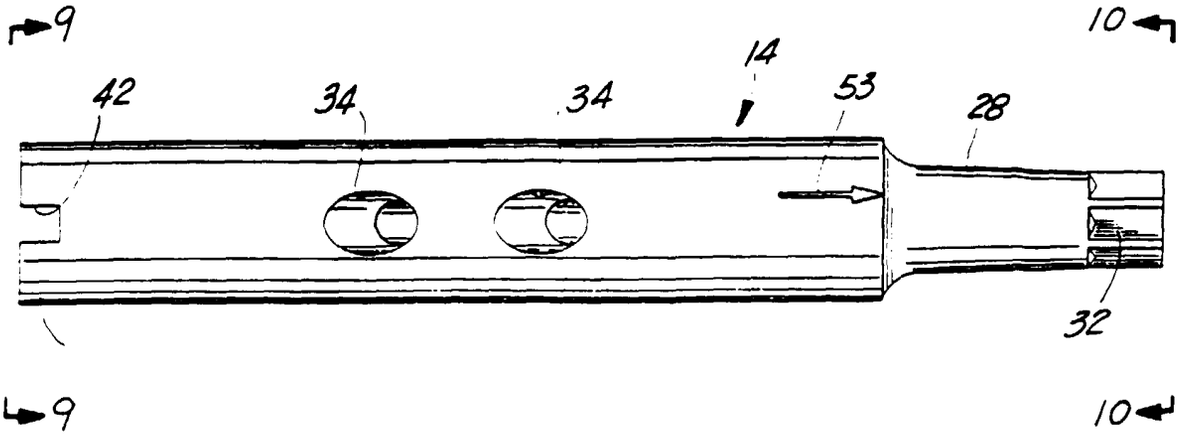


FIG. 8

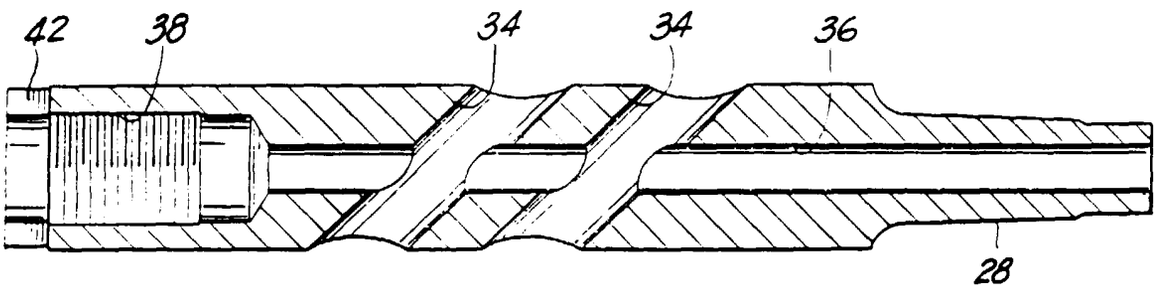


FIG. 9

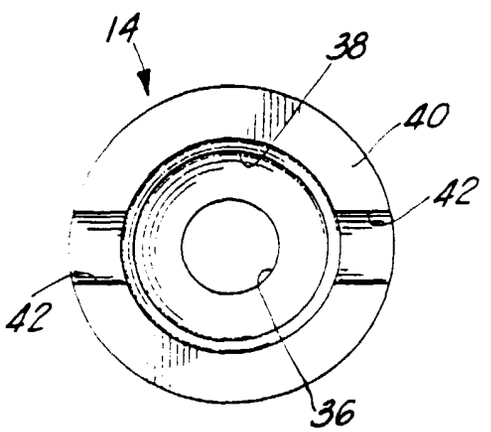


FIG. 10

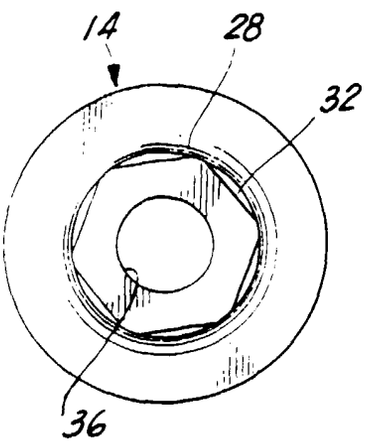
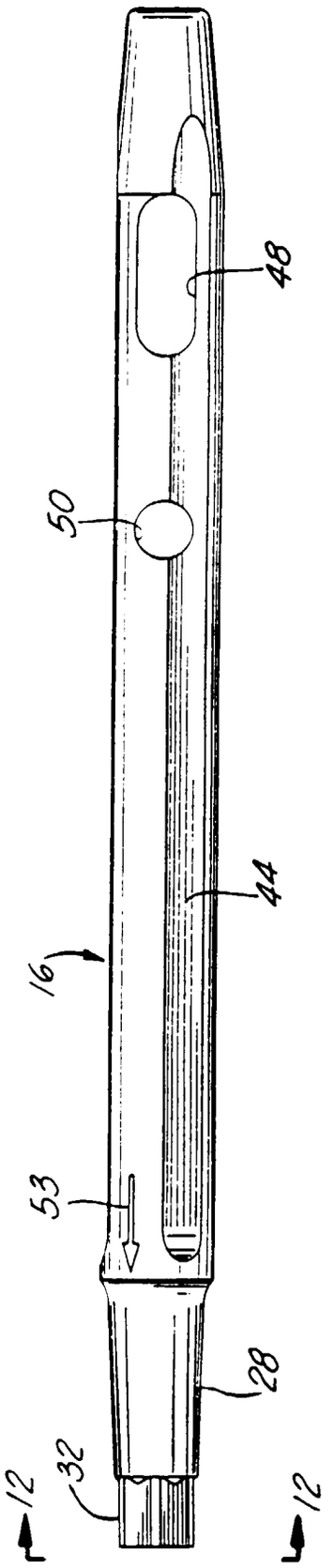


FIG.11



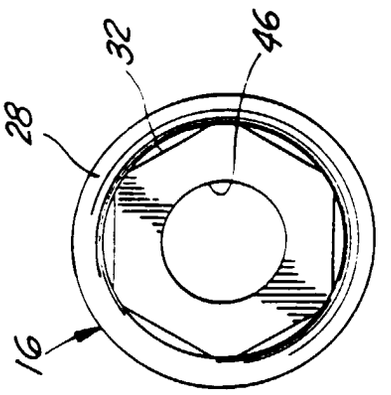


FIG.12

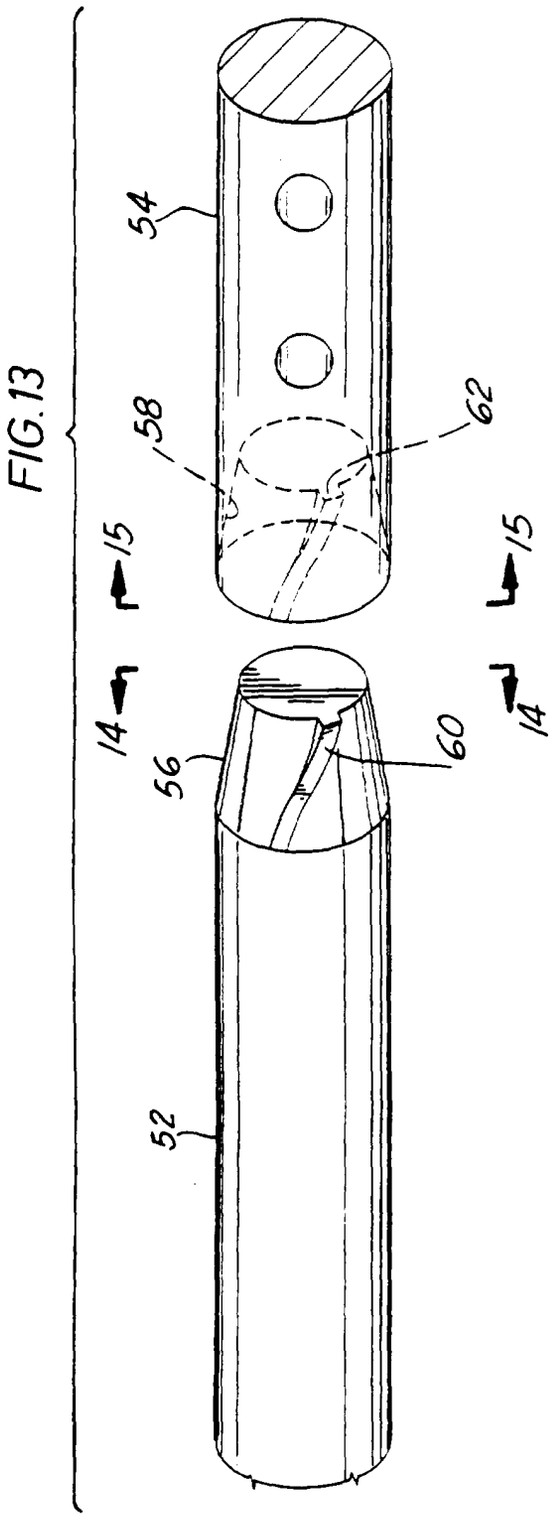


FIG. 13

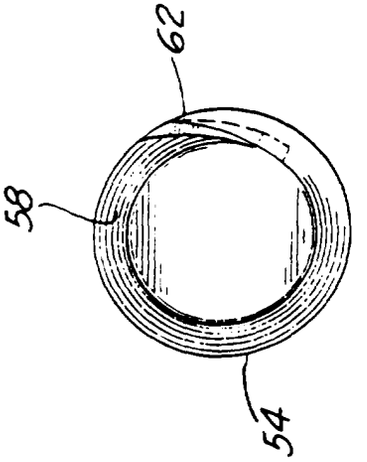


FIG. 15

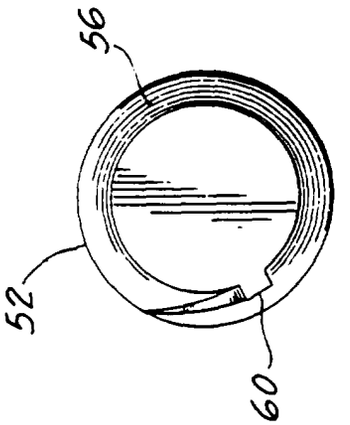


FIG. 14

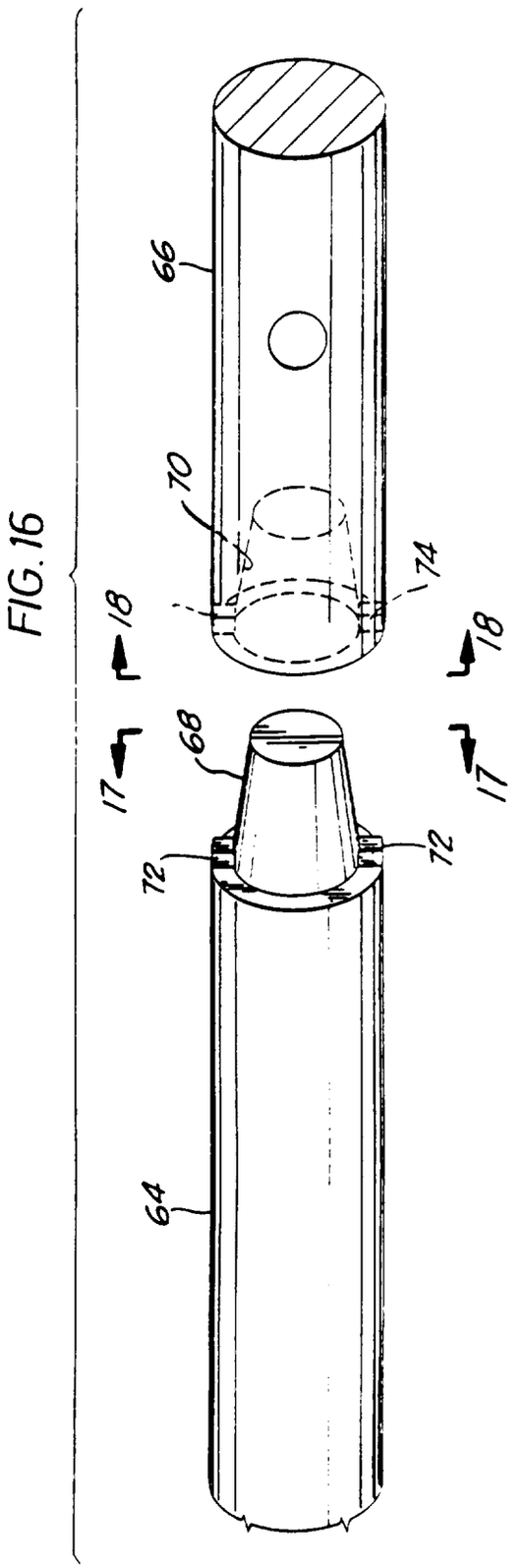


FIG.16

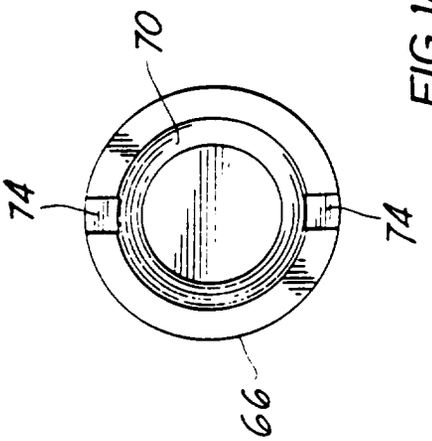


FIG.18

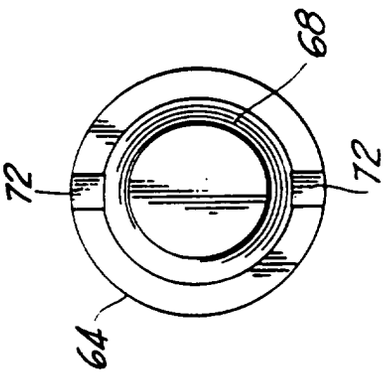


FIG.17

FIG. 19

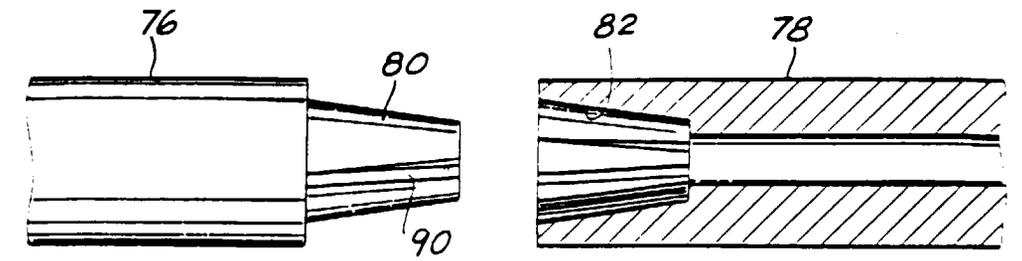


FIG. 20

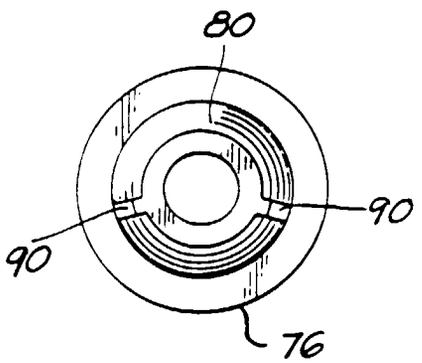


FIG. 21

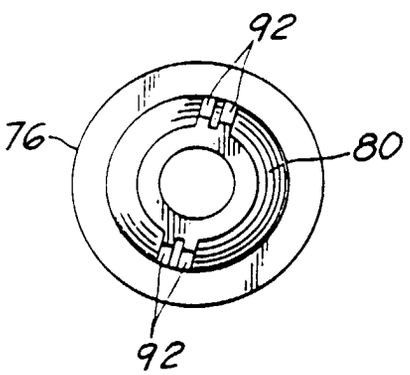


FIG. 22

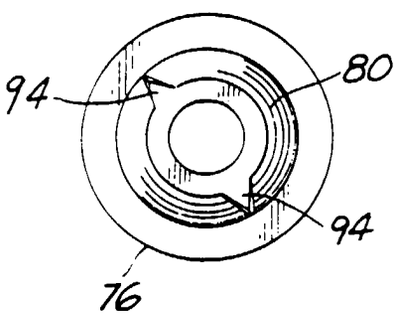


FIG. 23

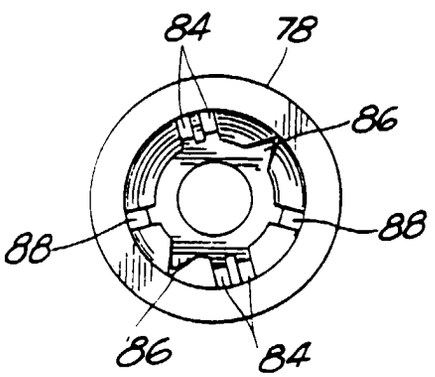


FIG. 24

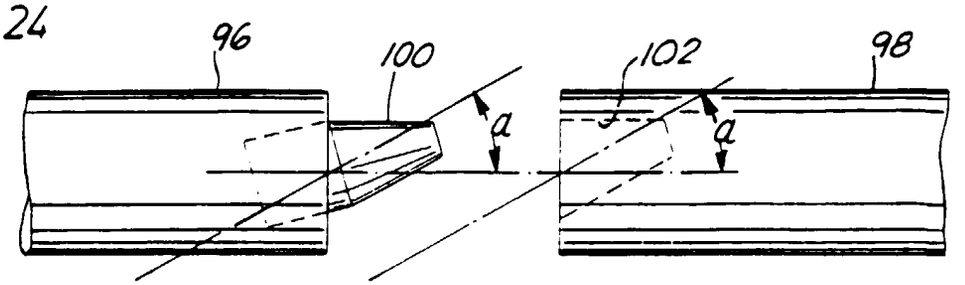


FIG. 25

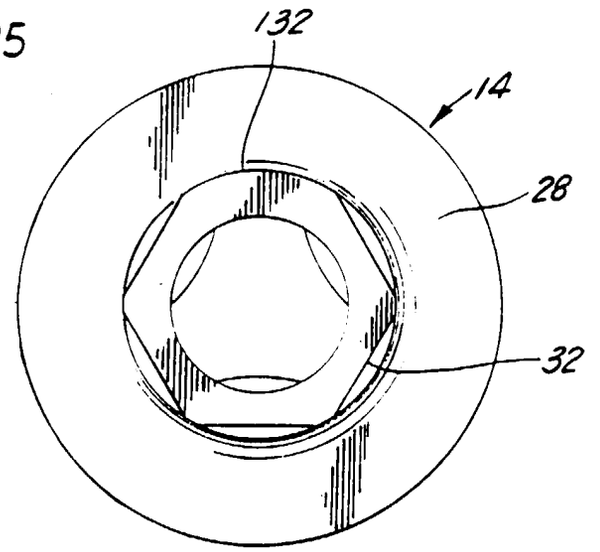


FIG. 26